Assessment of Technetium Leachability in Cement-Stabilized Basin 43 Groundwater Brine

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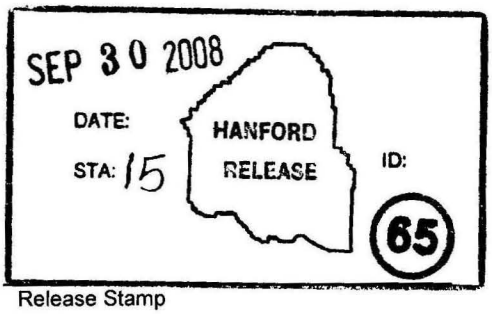
Abstract: This report is an initial report on the laboratory effort executed under RPP-PLAN-33338, Test Plan for the Assessment of Technetium Leachability in Cement-Stabilized Basin 43 Groundwater Brine. This report delineates preliminary data obtained under subcontract 21065, release 30, from the RJ Lee Group, Inc., Center for Laboratory Sciences. The report is predicated on CLS RPT-816, Draft Report: Assessment of Technetium Leachability in Cement Stabilized Basin 43 Groundwater Brine. This document will be revised on receipt of the final RJ Lee Group, Inc., Center for Laboratory Sciences report, which will contain data subjected to quality control and quality assurance criteria.



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Acronyms

ANSI	American National Standards Institute
EPA	U.S. Environmental Protection Agency
ICP-MS	inductively coupled plasma-mass spectrometer
ORP	oxidation-reduction potential
TCLP	Toxicity Characteristic Leaching Procedure

1. INTRODUCTION

This report is an initial report on the laboratory effort executed under RPP-PLAN-33338, *Test Plan for the Assessment of Technetium Leachability in Cement-Stabilized Basin 43 Groundwater Brine*. This report delineates **preliminary data** obtained under subcontract 21065, release 30, from the RJ Lee Group, Inc., Center for Laboratory Sciences. The report is predicated on CLS-RPT-816, *Draft Report: Assessment of Technetium Leachability in Cement Stabilized Basin 43 Groundwater Brine*. This document will be revised on receipt of the final RJ Lee Group, Inc., Center for Laboratory Sciences report, which will contain data subjected to quality control and quality assurance criteria.

2. MATERIALS AND METHODS

This section describes the activities around the Basin 43 Groundwater simulant (referred hereafter as simulant), testing of technetium getters, distribution coefficients (K_d), cement matrix, Toxicity Characteristic Leaching Procedure (TCLP), and the American National Standards Institute Leach Procedure (ANSI Leach). The preliminary results are reported in Chapter 3.

2.1 SIMULANT FORMULATION

The simulant used is shown in Table 1. The simulant is a concentrated brine consisting of approximately 25 wt% salts.

Table 1. Simulant Formulation for Basin 43 Evaporated Groundwater.

Reagent	Gram/Liter
$NaNO_3$	140.7948
$MgSO_4$	19.6177
$AlCl_3$	0.1337
KCl	2.7886
$BaCl_2$	0.0235
NaF	1.4126
$CaCl_2$	7.9349
Na_2CrO_4	0.1424
$Ca(OH)_2$	5.5384
$Ca(NO_3)_2$	42.3001
$NaHCO_3$	37.8555
Total	**258.5422**

The simulant used was formulated to match the anticipated Basin 43 waste from the Effluent Treatment Facility. The simulant is based on data obtained from wells 299-W11-45 and 299-W11-46.

2.2 TECHNETIUM GETTERS

The technetium getters initially chosen for the effort were identified in RPP-RPT-26742, *Hanford Containerized Cast Stone Facility Task 1 – Process Testing and Development Final Test Report*. The initial technetium getters are presented in Table 2.

Table 2. Candidate Technetium Getters.

Material	Source
Bone black	Ebonex
Fish bone	UFA ventures
Ferrous sulphate	Fisher Scientific
Zero valent iron	Fisher Scientific
Sodium metabisulfite	Effluent Treatment Facility

During the progression of the laboratory effort, other getters were identified. The first of which was iron (III) phosphate, which was tested immediately after the candidates in Table 2. The sodium metabisulfite was discarded due to the deleterious effect on the chrome passivating layer in 304 and 316L stainless steel. The revision will also report on those getters that were identified later into the laboratory effort, and experimental data is not yet available as of this report.

2.3 DISTRIBUTION COEFFICIENT

Distribution coefficients (K_d) were calculated from data gathered using the following experiment:

To a simulant solution of known TcO_4^- concentration (currently estimated to be 92.17 ppm Tc^{-7} or 1.5E-03 Ci/L), the following conditions applied for each material listed in Table 2 (Figure 1):

- Solution 1 — No oxidation-reduction potential (ORP) adjust (blank)
- Solution 2 — ORP adjust (to -400 mV) + no getter
- Solution 3 — ORP adjust (to -400 mV) + getter
- Solution 4 — Getter no ORP adjust

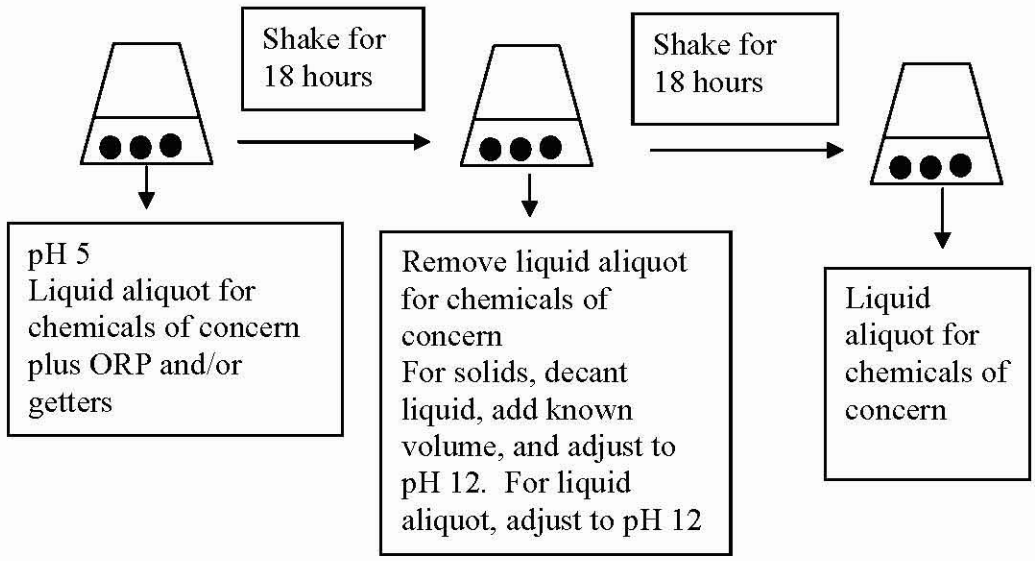
2.4 CEMENTITIOUS MATRIX

After the distribution coefficient tests, the samples were cast in the grout formulation shown in Table 3. This formulation was modified from formulation 8A (referenced in RPP-PLAN-33338) to reduce excess bleedwater. The cement samples cured for a 28-day period before final leach testing. The castings were cured at approximately 130 °F for a minimum of 24 hours to simulate temperatures that would be encountered if cast as a large monolith.

Table 3. Grout Formulation 8A.

Material	Amount
Brine:Solids ratio	1.1:1
Basin 43 waste	110 g
Portland cement	66.6 g
Slag	33.3 g

Figure 1. Flowsheet for the Determination of the Technetium Distribution Coefficient (K_d).



2.5 TOXICITY CHARACTERISTIC LEACHING PROCEDURE

U.S. Environmental Protection Agency (EPA) SW-846 Method 1311, "Toxicity Characteristic Leaching Procedure," was carried out on the cured samples. The resultant leacheate was analyzed for technetium using an inductively coupled plasma-mass spectrometer (ICP-MS) PerkinElmer[1] ELAN DRC-e.

At the conclusion of the 28-day cure period the monoliths identified for TCLP analysis were crushed in their casting vessels to the necessary grain size. Each monolith yielded ~40 to 56 g of sample, which was added to ~800 to 1000 g of TCLP extraction fluid 2 (glacial acetic acid at pH of 2.88), and then subjected to continuous rotation at 30 ± 2 rpm for 18 ± 2 hours. The leached portions continued to be subjected to the acetic acid environment for an additional 24 hours prior to the removal of aliquots for ICP-MS preparation and analysis via EPA 3005A and EPA 200.8.

[1] PerkinElmer is a registered trademark of the Perkin Elmer Corporation, Wellesley, Massachusetts.

2.6 AMERICAN NATIONAL STANDARDS INSTITUTE LEACH PROCEDURE

The castings were also subjected to the protocol outlined in ANSI/ANS-16.1-2003, *Measurement of the Leachability of Solidified Low-Level Radioactive Wastes by a Short-Term Test Procedure.*

The casting matrix for the TCLP and ANSI Leach is presented in Table 4.

Table 4. Casting Matrix for TCLP and ANSI Procedures. (2 sheets)

Description	Material	Units (g)	Number Cast for TCLP	Number Cast for ANSI/ANS 16.1
Cold blank	Basin 43 GW brine - ^{99}Tc	110	2	2
	Portland cement:	33.34		
	Blast furnace slag:	16.7047		
	Getter: none	---		
Hot blank	Basin 43 GW brine + ^{99}Tc	109.71	2	2
	Portland cement	66.612		
	Blast furnace slag	33.37		
	Getter: none	---		
Fishbone	Basin 43 GW brine + ^{99}Tc	110	2	2
	Portland cement:	66.63		
	Blast furnace slag:	33.29		
	Getter: fishbone	10.01		
Zero valent iron	Basin 43 GW brine + ^{99}Tc	110.09	2	2
	Portland cement:	66.6		
	Blast furnace slag:	33.34		
	Getter: Zero valent iron	10		
Bone black	Basin 43 GW Brine + ^{99}Tc	110.02	2	2
	Portland cement:	66.6		
	Blast furnace slag:	33.31		
	Getter: bone black	10.01		
Iron III phosphate	Basin 43 GW brine + ^{99}Tc	110	2	2
	Portland cement:	66.675		
	Blast furnace slag:	33.33		
	Getter: iron III phosphate	10		
Hydrotalcite	Basin 43 GW Brine + ^{99}Tc	66.0065	2	2
	Portland cement:	39.99		
	Blast furnace slag:	19.99		
	Getter: Hydrotalcite	6.05		
Fishbone ORP adjusted	Basin 43 GW brine + ^{99}Tc	110.05	2	2
	Portland cement:	66.62		
	Blast furnace slag:	33.32		
	Getter: fishbone	10.02		
Bone black ORP adjusted	Basin 43 GW brine + ^{99}Tc	110.01		
	Portland cement:	66.61		
	Blast furnace slag:	33.3		
	Getter: bone black	10.02		

Table 4. Casting Matrix for TCLP and ANSI Procedures. (2 sheets)

Description	Material	Units (g)	Number Cast for TCLP	Number Cast for ANSI/ANS 16.1
Zero valent iron ORP adjusted	Basin 43 GW brine + ^{99}Tc	110.02	2	2
	Portland cement:	66.6		
	Blast furnace slag:	33.3		
	Getter: zero valent iron	10.01		
Iron III phosphate ORP adjusted	Basin 43 GW brine + ^{99}Tc	110.01	2	2
	Portland cement:	66.63		
	Blast furnace slag:	33.03		
	Getter: iron III phosphate	10.04		
Hot blank ORP adjusted	Basin 43 GW brine + ^{99}Tc	110.01	2	2
	Portland cement:	66.62		
	Blast furnace slag:	33.31		
	Getter: none	--		

The monoliths produced for the ANSI/ANS 16.1 preparation and analysis are cylindrical and on average 3.5 cm in height with a diameter of 2.9 cm. The surface area (S) is 45.1 cm^2. The volume of deionized water necessary for leaching the monoliths as proscribed in the method is 451 ± 90.2 mls as determined by

$$V_L\ (cm^3)/S\ (cm_2) = 10 +/- 0.2\ (cm).$$

A clean 500-mL Teflon[2] jar fitted with a screened dipper and lid was used for each leaching interval. These vessels permitted the monolith to be submerged and suspended in the water column with minimal surface occlusion. To control for potential evaporation, the vessels were securely capped during each leaching interval.

At the conclusion of the 28-day cure period, the monoliths identified for ANSI/ANS 16.1 preparation and analysis were removed from the cure vessels as a solid cylinder. Every effort was made to ensure the integrity of the entire monolith. The leaching procedure as prescribed by ANSI/ANS 16.1 requires use of deionized water as the extraction medium. A sample of each leaching solution was drawn off immediately following the leach interval end time. The monolith was then resubmerged in a fresh deionized water bath.

Table 5 shows the ANSI Leach schedule (time line) for the associated analyses.

[2] Teflon® is a registered trademark of I. E. du Pont de Nemours and Company, Wilmington, Delaware.

Table 5. ANSI Leach Schedule.

Prep Method	Prescribed Leach Time	Leaching Start Date	Start Time	End Time	Leaching End Date	Total Time
ANSI/ANS	2 hours	7/25/2008	12:20	14:22	7/25/2008	122 minutes
ANSI/ANS	5 hours	7/25/2008	14:46	19:26	7/25/2008	160 minutes
ANSI/ANS	17 hours	7/26/2008	20:00	13:13	7/27/2008	1033 minutes
ANSI/ANS	24 hours	7/27/2008	13:52	13:42	7/28/2008	1430 minutes
ANSI/ANS	24 hours	7/28/2008	14:03	13:36	7/29/2008	1413 minutes
ANSI/ANS	24 hours	7/29/2008	14:06	13:47	7/30/2008	1421 minutes
ANSI/ANS	24 hours	7/30/2008	14:13	15:20	7/31/2008	1447 minutes
	120 hours					7026 minutes
						117 hours

3. RESULTS

3.1 DISTRIBUTION COEFFICIENT

Table 6 shows the calculated values of the K_d values versus the getters.

Table 6. Preliminary Results Distribution Coefficients (ORP adjusted are highlighted).

Getter	pH	ORP Adjust to -400 mV	K_d
Bone black	5-6	No	4.84
Bone black	12	No	NA*
Bone black	12	Yes	6066.2
Fishbone	5-6	No	4.83
Fishbone	12	No	0
Fishbone	12	Yes	6397.6
Zero valent iron	5-6	No	13.9
Zero valent iron	12	No	NA
Zero valent iron	12	Yes	9202.4
Iron (III) phosphate	5-6	No	1.57
Iron (III) phosphate	12	No	8.17
Iron (III) phosphate	12	Yes	1823.3

* NA = the sample showed more technetium after reaction with the getter, yielding a negative K_d value.

Table 7 shows the getters as a percent recovery of technetium.

Table 7. Preliminary Results Percent Recovery, (ORP adjusted are highlighted).

Sample	pH	ORP Adjust to -400 mV	^{99}Tc, after getter (mg/L)	^{99}Tc, before getter (mg/L)	Recovery (%)
Cold blank	5-6	No	<0.050	<0.050	NA
Cold blank	12	Yes	<0.050	<0.050	NA
Hot blank	5-6	No	7.1	8.5	84
Hot blank, duplicate	5-6	No	7.1	8.5	84
Hot blank	12	No	5.8	8.5	68
Hot blank, Duplicate	12	No	5.8	8.5	68
Hot blank	12	Yes	0.027	8.5	0
Bone black	5-6	No	6.8	7.1	96
Bone black	12	No	7.3	5.8	126
Bone black	12	Yes	0.10	5.8	2
Fishbone	5-6	No	6.8	7.1	96
Fishbone	12	No	5.8	5.8	100
Fishbone	12	Yes	0.096	5.8	2
Zero valent iron	5-6	No	6.3	7.1	89
Zero valent iron	12	No	7	5.8	121
Zero valent iron	12	Yes	0.068	5.8	1
Iron (III) phosphate	5-6	No	7	7.1	99
Iron (III) phosphate	12	No	5.4	5.8	93
Iron (III) phosphate	12	Yes	0.33	5.8	6

3.2 TOXICITY CHARACTERISTIC LEACHING PROCEDURE

The initial results are presented in Table 8.

Table 8. Preliminary Results of the TCLP (ORP adjusted are checked).

Getter	ORP Adjustment	Average ^{99}Tc, Concentration ppm
Cold blank		<0.0010
Hot blank		0.0066
Hot blank	✔	0.0089
Fishbone		0.0072
Fishbone	✔	0.0091
Zero valent iron		0.0029
Zero valent iron	✔	0.0082
Bone black		0.0087
Bone black	✔	0.0095
Iron III phosphate		0.0092
Iron III phosphate	✔	0.0082
Hydrotalcite		0.0132

3.3 AMERICAN NATIONAL STANDARDS INSTITUTE LEACH PROCEDURE

Table 9 gives the preliminary results of the ANSI Leach.

Table 9. ANSI/ANS 16.1 ICP-MS Preliminary Data. (3 sheets)

Getter ID	Lab ID	ORP Adjusted by Iron II Sulfate	Cumulative Leaching Time	Analyte	Result (mg/L)	Reporting Limit (mg/L)
Cold blank	WA310720080031-001	No	2 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Cold blank	WA310720080032-001	No	5 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Cold blank	WA010820080014-001	No	17 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Cold blank	WA010820080018-001	No	48 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Cold blank	WA010820080002-001	No	72 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Cold blank	WA010820080018-001	No	96 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Cold blank	WA310720080031-001	No	120 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Hot blank	WA310722080031-003	No	2 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Hot blank (average)	**WA310720080031-022**	**Yes**	**2 hours**	**$^{99}Tc^{7+}$**	**0.0010**	**0.0010**
Hot bank	WA310722080032-003	No	5 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Hot blank	WA310720080032-022	Yes	5 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Hot blank	WA010820080014-003	No	17 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Hot blank	WA010820080014-022	Yes	17 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Hot blank	WA010820080001-003	No	48 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Hot blank	WA010820080001-022	Yes	48 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Hot blank	WA010820080002-003	No	72 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Hot blank	WA010820080002-022	Yes	72 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Hot blank	WA010820080018-003	No	96 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Hot blank	WA010820080018-022	Yes	96 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Hot blank	WA310722080031-003	No	120 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Hot blank	WA310722080031-022	Yes	120 hours	$^{99}Tc^{7+}$	<0.0010	0.001
Bone black	WA310720080031-009	No	2 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Bone black	WA310720080031-016	Yes	2 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Bone black	WA310720080032-009	No	5 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Bone black	WA310720080032-016	Yes	5 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Bone black	WA010820080014-009	No	17 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Bone black	WA010820080014-016	Yes	17 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Bone black	WA010820080001-009	No	48 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Bone black	WA010820080001-016	Yes	48 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Bone black	WA010820080002-016	Yes	72 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Bone black (average)	**WA010820080002-009**	**No**	**72 hours**	**$^{99}Tc^{7+}$**	**0.008**	**0.0010**
Bone black	WA010820080018-009	No	96 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Bone black	WA010820080018-016	Yes	96 hours	$^{99}Tc^{7+}$	<0.0010	0.0010

Table 9. ANSI/ANS 16.1 ICP-MS Preliminary Data. (3 sheets)

Getter ID	Lab ID	ORP Adjusted by Iron II Sulfate	Cumulative Leaching Time	Analyte	Result (mg/L)	Reporting Limit (mg/L)
Bone black	WA310722080031-009	No	120 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Bone black	WA310722080031-016	Yes	120 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Fishbone	WA310720080031-005	No	2 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Fishbone	WA310720080031-014	Yes	2 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Fishbone	WA310720080032-007	No	5 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Fishbone	WA310720080032-014	Yes	5 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Fishbone	WA010820080002-005	No	17 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Fishbone	WA010820080014-014	Yes	17 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Fishbone	WA010820080001-005	No	48 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Fishbone	WA010820080001-014	Yes	48 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Fishbone	WA010820080002-005	No	72 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Fishbone	WA010820080002-014	Yes	72 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Fishbone	WA010820080018-005	No	96 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Fishbone	WA010820080018-014	Yes	96 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Fishbone	WA310722080031-005	No	120 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Fishbone	WA310722080031-014	Yes	120 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Hydrotalcite	WA310720080031-013	No	2 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Hydrotalcite	WA310720080032-013	No	5 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Hydrotalcite	WA010820080014-013	No	17 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Hydrotalcite	WA010820080001-013	No	48 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Hydrotalcite	WA010820080002-013	No	72 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Hydrotalcite	WA010820080018-013	No	96 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Hydrotalcite	WA310722080031-013	No	120 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Iron (III) phosphate	WA310720080031-011	No	2 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Iron (III) phosphate	WA310720080031-020	Yes	2 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Iron (III) phosphate	WA310720080032-011	No	5 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Iron (III) phosphate	WA310720080032-020	Yes	5 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Iron (III) phosphate	WA010820080014-011	No	17 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Iron (III) phosphate	WA010820080014-020	Yes	17 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Iron (III) phosphate	WA010820080001-011	No	48 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Iron (III) phosphate	WA010820080001-020	Yes	48 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Iron (III) phosphate	WA010820080002-011	No	72 hours	$^{99}Tc^{7+}$	<0.0010	0.0010

Table 9. ANSI/ANS 16.1 ICP-MS Preliminary Data. (3 sheets)

Getter ID	Lab ID	ORP Adjusted by Iron II Sulfate	Cumulative Leaching Time	Analyte	Result (mg/L)	Reporting Limit (mg/L)
Iron (III) phosphate	WA010820080002-020	Yes	72 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Iron (III) phosphate	WA010820080018-011	No	96 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Iron (III) phosphate	WA010820080018-020	Yes	96 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Iron (III) phosphate	WA310722080031-011	No	120 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Iron (III) phosphate	WA310722080031-020	Yes	120 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Zero valent iron	WA310720080031-007	No	2 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Zero valent iron	WA310720080031-018	Yes	2 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Zero valent iron	WA310720080032-018	No	5 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Zero valent iron	WA310720080032-019	Yes	5 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Zero valent iron	WA010820080014-007	No	17 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Zero valent iron	WA010820080014-018	Yes	17 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Zero valent iron	WA010820080001-007	No	48 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Zero valent iron	WA010820080001-018	Yes	48 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Zero valent iron	WA010820080002-007	No	72 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Zero valent iron (Average)	**WA010820080002-018**	**Yes**	**72 hours**	**$^{99}Tc^{7+}$**	**0.0022**	**0.0010**
Zero valent iron	WA010820080018-007	No	96 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Zero valent iron	WA010820080018-018	Yes	96 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Zero valent iron	WA310722080031-007	No	120 hours	$^{99}Tc^{7+}$	<0.0010	0.0010
Zero valent iron	WA310722080031-018	Yes	120 hours	$^{99}Tc^{7+}$	<0.0010	0.0010

4. CONCLUSIONS

With the data in the preliminary stages, it is difficult to converge on conclusions. However, it is probably safe to conclude that the ORP adjustment to -400 mV versus standard hydrogen electrode does effectively reduce technetium from the +7 oxidation state to the +4 state. The +4 state is one in which the technetium oxide (TcO_4) is stable and exhibits a black precipitate (*Atlas of Electrochemical Equilibria in Aqueous Solutions*, Pourbaix 1974).

It is also concluded that the candidate getters would be effective in dilute solutions of pertechnetate and were not that effective in high salinity solutions, with the exception of the addition of ferrous sulfate to obtain a solution ORP of -400 mV. There appears to be two effects exhibited by the high salinity solution. One is based on salinity itself indicating a percent reduction of technetium (Table 7). Table 7 also indicates the effect of using ferrous sulfate to adjust the solution ORP to achieve a reduced oxidation state.

Once data is finalized, a revision of this report will be issued. It is expected that the conclusion section of the revision will be significantly expanded.

5. REFERENCES

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